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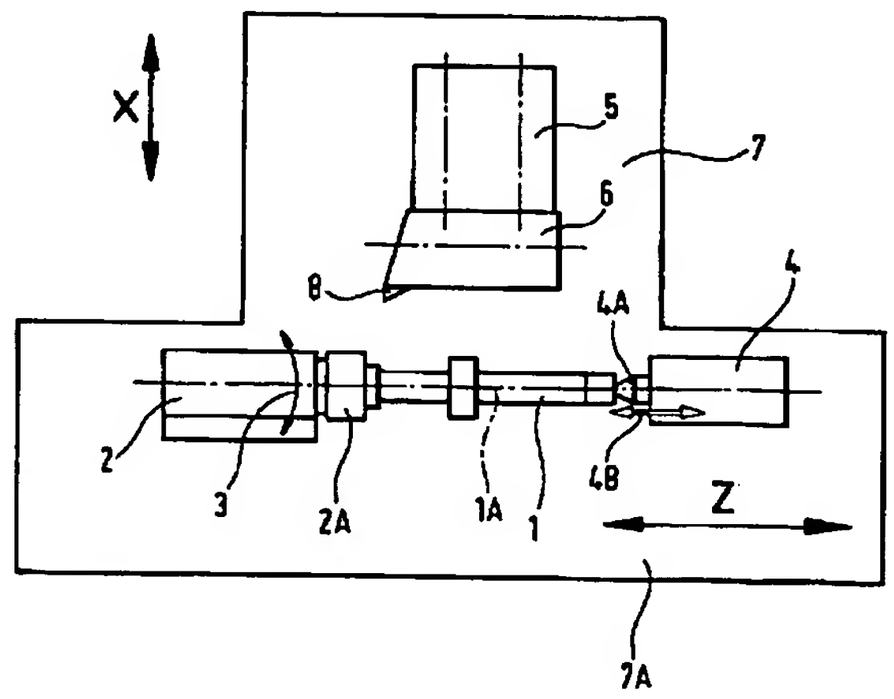
(54) RECTIFIEUSE AVEC PIECE TOURNANTE
(54) GRINDING MACHINE WITH HARD-TURNING ATTACHMENT

(57)

The invention relates to a grinding machine comprising at least one bed, feed slides and a grinding table with superstructures, which further presents a turning-tool holding fixture (6) for hard machining. The invention also relates to a method for machining a workpiece (1) in a grinding machine, according to which the workpiece (1) is hard-machined by turning in said grinding machine.



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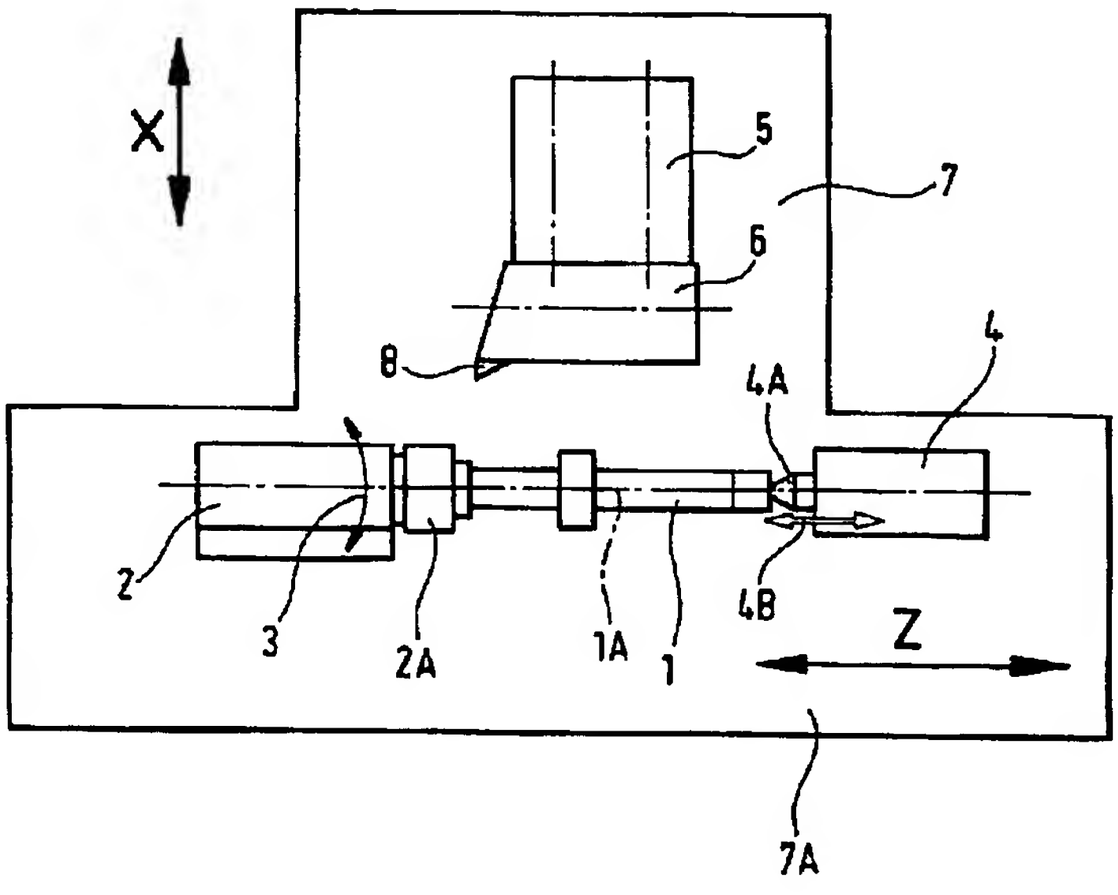
(54) **RECTIFIEUSE AVEC PIECE TOURNANTE**
(54) **GRINDING MACHINE WITH HARD-TURNING ATTACHMENT**



(57) The invention relates to a grinding machine comprising at least one bed, feed slides and a grinding table with superstructures, which further presents a turning-tool holding fixture (6) for hard machining. The invention also relates to a method for machining a workpiece (1) in a grinding machine, according to which the workpiece (1) is hard-machined by turning in said grinding machine.

Abstract

The present invention provides a grinding machine having at least a grinding-machine bed, a feed slide and a grinding table with mounted table accessories and having a turning-tool holder (6) provided for hard turning. A method of machining a workpiece (1) in a grinding machine is also proposed, in which method hard turning is carried out on the workpiece (1) in the grinding machine.

(Figure 1)

Grinding machine with hard-turning attachment

The invention relates to a grinding machine having at least a grinding-machine bed, a feed slide and a grinding table with mounted table accessories and to a method of machining a workpiece in a grinding machine.

Grinding machines for the conventional and CNC-controlled grinding of shafts and flange parts are already known. Conventional and CNC-controlled turning machines are also known, in which case there are machining centres on which workpieces can be machined and on the tool-holding device of which a grinding spindle is mounted, this grinding spindle making it possible to grind sealing ring seats, for example, free of twist. These seats are generally rough-turned and are then ground on the outside once again only on account of the requisite surface quality. A grinding unit required for this is designed as an auxiliary grinding attachment. This auxiliary grinding attachment makes it possible for only this particular process to be run on such machining centres. This generally involves special designs of machine tools with which only a precisely defined and predetermined workpiece can be machined.

The object of the invention is to provide a grinding machine which can be used in an extremely flexible manner and which permits an increase in productivity compared with previous grinding machines.

To achieve this object, a grinding machine having the features of Claim 1 and a method having the features of Claim 19 are proposed according to the invention. Additional features relate to a turning-tool holder and a turning-tool-holding plate. Expedient developments are contained in the respective subclaims.

According to the invention, a grinding machine is used which has a grinding-machine bed which is already designed for grinding and whose rigidity, temperature variation behaviour and vibration behaviour, etc., are already optimized for precisely this task. The grinding machine has at least a grinding-machine bed, a feed slide and a grinding table with mounted table accessories. Furthermore, a turning-tool holder for hard turning is provided. It is thus possible to not only completely finish-grind a workpiece in one set-up. On the contrary, the turning-tool holder makes it possible for a turning tool or another cutting tool to also be used and for the workpiece to be machined either before, during or after the grinding. This extends the range of use of the grinding machine, although grinding is preferably still its main function. Therefore the grinding machine also still expediently has devices such as steady rests, etc., as mounted table accessories.

According to one configuration, the grinding machine has a spindle head to which the turning-tool holder is detachably fastened. This increases the flexibility by virtue of the fact that existing components of the grinding machine are used in order to perform an additional function. The spindle head serves, for example, as a carrier for a grinding wheel or a turning tool. A development provides for the spindle head to be capable of being swivelled. As a result, different tools can in each case be moved into the requisite engagement position at the workpiece. In addition, this enables a controlled swivelling device of the spindle head to be utilized with a control for various tools.

The grinding machine preferably has the turning-tool holder arranged in addition to a grinding spindle. Thus resetting times for the use of different tools do not apply. A workpiece can therefore be ground and turned in a continuous operation. The turning-tool

holder is expediently a tool turret. The latter has a plurality of different tools available, so that, during an operating sequence which is appropriately programmed, for example, no interruption with tool stop and tool change need be effected.

A development of the grinding machine has the turning-tool holder designed as an interchangeable turning-tool-holding plate. This simplifies tool use and a tool change.

In a further design of the grinding machine, this grinding machine has a grinding spindle which has a holder on which a grinding wheel or a turning-tool-holding plate can be attached. In particular, the turning-tool-holding plate can be clamped in place, preferably in such a way that it is positioned radially on the grinding spindle. Therefore the holder is expediently arranged at least in radial proximity.

In addition to the grinding operation itself, the grinding machine must also be able to meet the demands made on it during the hard-turning operation. A configuration with which a high machining quality is possible while at the same time utilizing any existing components of the grinding machine has the grinding spindle designed as a tool turret which can be positioned radially via a displacement measuring system by means of an electronically oriented spindle stop. The accuracy achieved as a result can be utilized for the grinding, on the one hand, and for the turning.

Furthermore, for a quick tool change and thus for shortening the production time, it has proved to be advantageous that the grinding machine has a turning tool mounted on a radially indexable turning-tool-holding plate.

Further accuracy and also shortening of the machining time are achieved owing to the fact that the grinding machine has a mounting housing for the grinding spindle or the tool turret, in which case the mounting housing can be swivelled horizontally on a feed slide. This allows a control of the feed slide to be utilized for the motion of the grinding spindle or the tool turret and at the same time ensures a rapid exchange of grinding spindle and tool turret by means of the mounting housing.

Further flexibility of the grinding machine is achieved owing to the fact that two independently traversable feed slides for the turning-tool holder are mounted in the direction X1/X2/Z1/Z2 on a grinding-machine frame of the grinding machine. This enables turning to be carried out simultaneously at various positions of the tool. Furthermore, if both feed slides are arranged opposite one another, it can be ensured that one of the two feed slides brings a turning tool into engagement in the workpiece, while the other feed slide can be retooled. It is also advantageous if two independently traversable feed slides which carry different tools in each case, for example a grinding wheel and a turning tool, are used.

To shorten the machining time, the grinding machine, in a development, also provides the function that the turning-tool holder accommodates tools for external and/or internal turning. As a result, unclamping and reclamping in another machine tool is not required.

On account of the basic function as a grinding machine, this grinding machine is of conventional configuration. For the additional machining possibility, the grinding machine preferably has a guideway cover and/or a chip-removal device which is adapted to the respective machining operation. In particular, the guideway cover and/or the chip-removal device may also be separate

from the grinding machine and may then be fastened to the grinding machine for the respective intended use. Further individual parts are also a turning-tool-holding plate adapted to the grinding machine and a turning-tool holder. The turning-tool-holding plate for a turning tool has a connecting part. The connecting part is appropriately adapted for connection to the grinding machine. Likewise, the turning-tool holder for a turning tool has a connecting part which is appropriately adapted for mounting with the grinding machine.

The grinding machine having a turning-tool holder permits a modular construction of the different functions of grinding and turning, a factor which also permits retrofitting in the case of grinding machines which can be used in an appropriate manner for hard turning. To this end, an appropriate turning-tool holder and also a turning-tool-holding plate, a tool turret or another of the abovementioned components may be additionally provided as a retrofit set on an already existing grinding machine.

At least one holder for a turning tool or a tool turret for accommodating turning tools is preferably mounted on the grinding-machine bed, so that advantages of the grinding-machine construction can be utilized for hard turning. In particular, advantages are also obtained through the use of a feed slide of the X-axis, this feed slide being in use for the grinding, for accommodating the tool holder or the turret head for the turning tools. Expedient further advantages for this turning machine are obtained from the design of the grinding machine with regard to the grinding table with the guides and the drive for the Z-axis.

The machine tool is expediently built as a grinding machine to such an extent that a turning-tool holder is mounted on a commercially available grinding machine,

and guideway covers and chip-removal devices correspondingly required for the chip flow of the turning are attached. As a result, this enables a turning-tool holder or a tool turret which are designed for hard turning to be mounted instead of the grinding spindle with grinding-wheel adaptor. Furthermore, a grinding spindle of appropriate design having a corresponding grinding-wheel adaptor may also be used, so that, instead of the grinding wheel, a tool holder for turning tools may be attached. The tool holder may be designed in such a way that it is mounted on the grinding spindle in exactly the same way as a grinding wheel. A tool-holding plate for the turning tools is appropriately fixed radially and clamped on this grinding spindle and positioned radially via a displacement measuring system by means of an electronically oriented spindle stop.

Furthermore, a method of machining a workpiece in a grinding machine is proposed, in which method hard turning is carried out on the workpiece in the grinding machine. Instead of or in addition to the grinding, the method also permits other machining to be carried out, in particular as additional machining, for example either before, during or after the grinding. Furthermore, the method, in a development, provides for grinding and turning to be carried out on the workpiece. To shorten the machining time, the workpiece is left in a set-up during a change of a machining mode from grinding to turning, or vice versa. Reclamping in another machine is not required. The turning tool is preferably moved by means of a control for a grinding spindle. As a result, there is no need to resort to an additional control.

The invention is explained in more detail below with reference to the attached figures, in which case the advantageous features and configurations there can be

combined with those specified above to form developments. In the drawing:

Fig. 1 shows a plan view of a grinding-machine construction with a tool holder and a tool for hard turning;

Fig. 2 shows a plan view like Fig. 1 with a tool turret for hard turning;

Fig. 3 shows a side view of a tool-holding plate;

Fig. 4 shows a plan view of the grinding-machine construction with a tool turret which can be swivelled horizontally;

Fig. 5 shows a plan view like Fig. 4 with a grinding-spindle unit and a tool turret for hard turning;

Fig. 6 shows an arrangement of two opposite spindle heads with one turret head each;

Fig. 7 shows a plan view like Fig. 6 with a grinding spindle and a turret head for hard turning; and

Fig. 8 shows a view of a hard-turning machine with a first and a second tool turret.

Figure 1 shows a plan view of a grinding-machine construction which is equipped for hard turning. The machine construction is only shown schematically and serves to explain the invention. The machine bed is designed in the same way as in a grinding machine. In the front region of the machine bed 7A, a headstock 2 is mounted on a grinding table (not shown) traversable in the direction of the CNC axis Z, and this headstock 2, on a motor-driven work spindle (compare arrow 3), accommodates a chuck 2A for clamping and driving a workpiece 1. The workpiece 1 is supported at the other

end by means of a centre, which is fastened to a tailstock quill 4A, which is hydraulically traversable (compare arrow 4B) for loading and unloading. The centre axes of the work spindle of the headstock 2, of the chuck 2A, of the tailstock quill 4A and of the workpiece 1 form a common centre axis 1A. A feed slide 5, which is preferably traversable at right angles to the workpiece centre axis 1A and thus also to the traverse direction of the Z-axis and on which a tool holder 6 for turning tools is mounted, is located in the rear region of the machine bed. The feed slide 5 is traversed by means of a CNC axis (compare arrow X). The turning tool 8, which is preferably designed as a CBN or PCD indexable insert, is likewise schematically shown.

Figure 2 likewise shows a machine construction like Fig. 1, although in this case a turret head 9 is mounted as tool holder on the feed slide 5. The turret head accommodates a tool-holding plate 11, traversable mechanically or by means of a CNC axis. The CBN or PCD indexable inserts 12 can be clamped in place on the tool-holding plate 11. The turret head 9 and the tool-holding plate 11 are movable radially about the common centre axis 13. The motion, in particular in the form of an indexed motion, is shown by the direction arrow 10.

Figure 3 shows a side view of the tool turret 9 and the tool-holding plate 11 according to arrow V from Fig. 2 and a section through the workpiece 1. The feed direction of the feed slide 5 is again shown here by arrow X. The tool-holding plate 11 serves to accommodate different tools and indexable inserts 12, 12A. The number of indexable inserts 12, 12A is freely selectable, eight indexable inserts being shown in this case. The tool-holding plate 11 can be indexed radially about the centre axis 13 by the turret head 9, preferably by a CNC axis (compare arrow 21). The tool-

holding plate 11 is firmly clamped on the turret head 9 by screws 23 with the aid of a clamping flange 22. Conventional quick-change systems can be used here. Preferably used is a quick-change system which has a tool-holding plate in which the tools are fixed, for example can be fastened free of play and in a detachable manner by means of a centring device as a tool turret and are thus interchangeable for resetting. The centring device has a three-point bearing which is effective between a journal and a centring ring in order to centre the tool-holding plate, a clamping flange being provided for clamping the tool-holding plate. The centring device preferably has a centring ring which has three equispaced lugs in the region of its bore, and these lugs can be brought into detachable and non-positive frictional engagement with likewise equispaced circular wedges on the outer circumference of the journal, which is connected to a drive shaft and extends through the bore.

Also shown in Fig. 3 is the workpiece 1, in which the tool engages. For turning, each individual tool can come into engagement. Thus, as shown, the tool 12 is instantaneously in engagement. By radial indexing of the tool-holding plate 11, the tool 12A, for example, or any other preselected tool can come into engagement.

Figure 4 shows a plan view of a machine concept with two tool turrets 14, 15. In Fig. 4, the tool turret 14, which accommodates the tool-holding plate 16, is in the machining position. By horizontal swivelling of the tool-turret mounting housing 20 on the feed slide 5, the tool turret 15 can be brought into the machining position, the centre axis of which tool turret 15 is then likewise parallel to the workpiece longitudinal axis 1A. The tool turret 14 is then swung out to the right, so that one of the two tool turrets 1, 15 can always be brought into the working position in a predeterminable manner.

Figure 5 shows a further embodiment, a grinding spindle 18 accommodating a grinding wheel 19, so that grinding and turning can be carried out on the grinding machine. The grinding may be effected with corundum or CBN grinding wheels.

Figure 6 shows a further embodiment of the grinding-machine construction for turning, the two tool turrets being arranged with their end faces opposite one another on the X1/Z1/X2/Z2 axes traversable by means of a CNC axis. In this way, machining in parallel over the productive time by means of the indexable inserts is possible, the indexable inserts being accommodated on the tool-holding plates of both turret heads.

Figure 7 shows the same arrangement, one of the two machining stations being designed as a grinding unit.

According to Fig. 8, a hard-turning machine has two units in the form of a first tool turret 24 and a second tool turret 25 which are arranged so that they can be swivelled about a horizontal centre axis in arrow direction B in a common plane. These tool turrets 24, 25 are mounted on a common feed slide 26 and enclose an angle which, in the exemplary embodiment shown, is greater than or equal to 60° and is at most 180°. A first tool 27 and a second tool 28 can thus be operated alternately when the workpiece 1 clamped between the headstock 2 and a tailstock 29 is to be machined.

However, this machine may also be configured in such a way that one unit is designed as a tool turret for turning and the other unit is designed as a grinding-spindle unit, so that turning is possible with the first unit and grinding is possible with the second unit.

External turning, in particular, may be inferred from the description of the figures. Depending on the type of workpiece, however, it is also possible to turn said workpiece internally. A corresponding adaptation of the grinding machine and the corresponding tool holders is possible. For example, workpieces on which bores are machined are preferably also clamped in a chuck without the support of a tailstock, that is in a chucking mechanism. This type of grinding machine thus allows the workpiece to not only be ground but also turned or bored in one set-up. Grinding machines of conventional type can thus be used in a more universal and more flexible manner.

List of designations

1	Workpiece
1A	Centre axis
2	Headstock
2A	Chuck
3	Drive direction
4A	Tailstock quill
4B	Traverse direction
5	Feed slide
6	Tool holder
7A	Machine bed
8	Turning tool
9	Turret head
10	Travel
11	Tool-holding plate
12	Indexable insert
13	Centre axis
14	Tool turret
15	Tool turret
16	Holding plate
18	Grinding spindle
19	Grinding wheel
20	Tool-turret mounting housing
21	Indexed travel
22	Clamping flange
23	Screw
24	First tool turret
25	Second tool turret
26	Common feed slide
27	First tool
28	Second tool
29	Tailstock

New patent claims

1. Grinding machine having a grinding-machine bed, a grinding spindle (18), a feed slide (5), a grinding table with mounted table accessories, and a work spindle, characterized in that a turning-tool holder (6) for accommodating at least two turning tools for hard turning is provided, the tool holder (6) having an interchangeable turning-tool-holding plate (11) which with respect to the grinding-spindle rotation axis can be clamped in place radially on the grinding spindle (18).

2. Grinding machine according to Claim 1, characterized in that the spindle head can be swivelled.

3. Grinding machine according to Claim 1 or 2, characterized in that the turning-tool holder (6) is arranged in addition to a grinding spindle (18).

4. Grinding machine according to one of the previous claims, characterized in that the turning-tool holder (6) is a tool turret (14, 15).

5. Grinding machine according to one of the previous claims, characterized in that the grinding spindle (18), as tool turret (14, 15), can be positioned radially with respect to the grinding-spindle rotation axis via a displacement measuring system by means of an electronically oriented spindle stop.

6. Grinding machine according to one of the previous claims, characterized in that a turning tool is mounted on a turning-tool-holding plate (11) which can be indexed radially about the rotation axis of the grinding spindle.

7. Grinding machine according to Claim 5, characterized in that a mounting housing for the grinding spindle (18) or the tool turret (14, 15) can be swivelled horizontally on a feed slide (5).

8. Grinding machine according to one of the preceding claims, characterized in that two independently traversable feed slides (5) for the turning-tool holder (6) are mounted in the direction X1/X2/Z1/Z2 on a grinding-machine frame of the grinding machine.

9. Grinding machine according to Claim 4, characterized in that the turning-tool holder (6) accommodates tools for external and/or internal turning.

10. Grinding machine according to one of the preceding claims, characterized in that it has a guideway cover and/or a chip-removal device which is adapted to the respective machining operation.

11. Turning-tool-holding plate (11) for a turning tool, having a connecting part, characterized in that the connecting part is adapted for connection to a grinding machine according to Claim 1.

12. Method of machining a workpiece in a grinding machine, in which method grinding and hard turning are carried out simultaneously on the workpiece in one set-up.

13. Method according to Claim 12, in which a turning tool (8) is moved by means of a control for a grinding spindle (18).

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Fig. 1

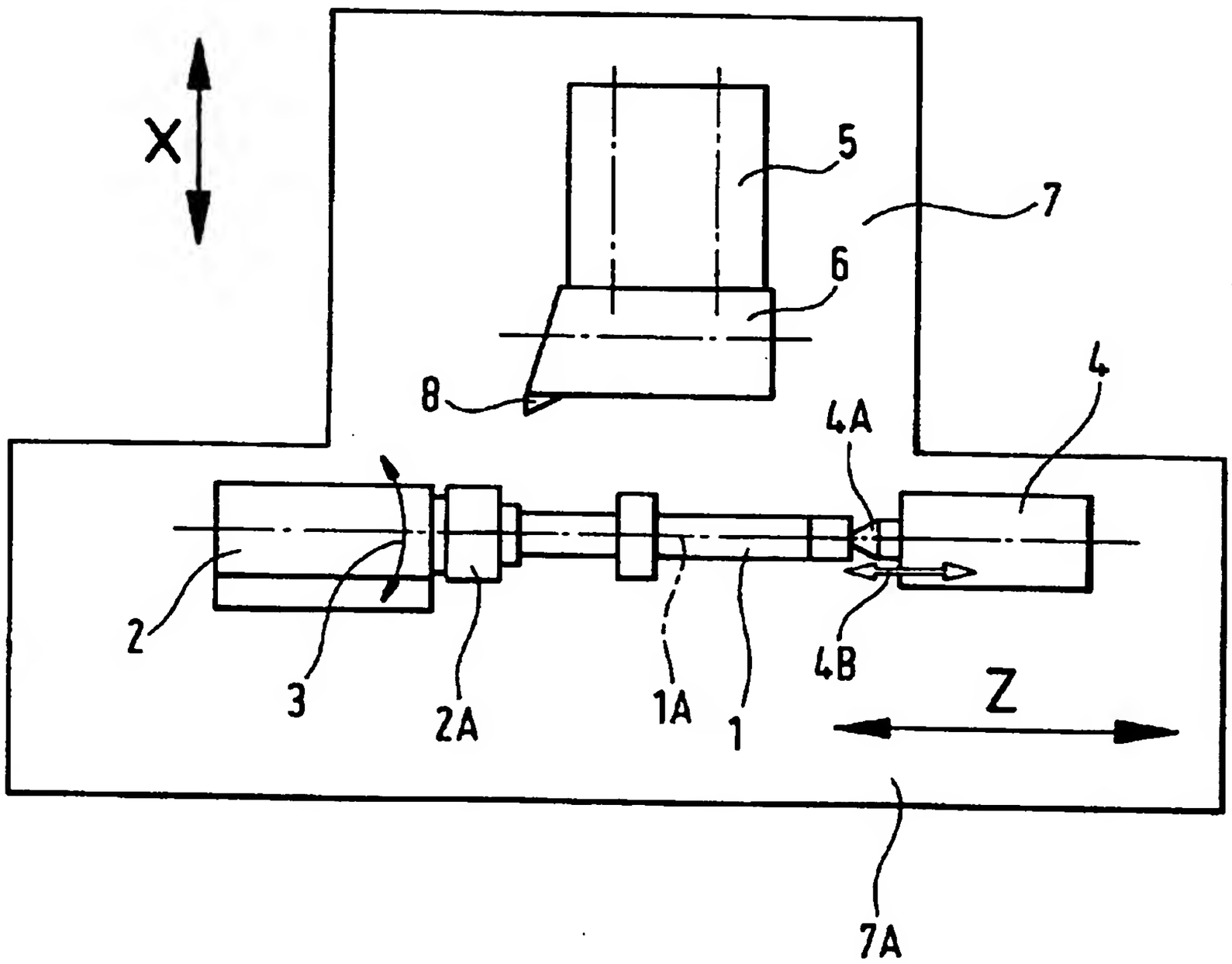

Fig. 2

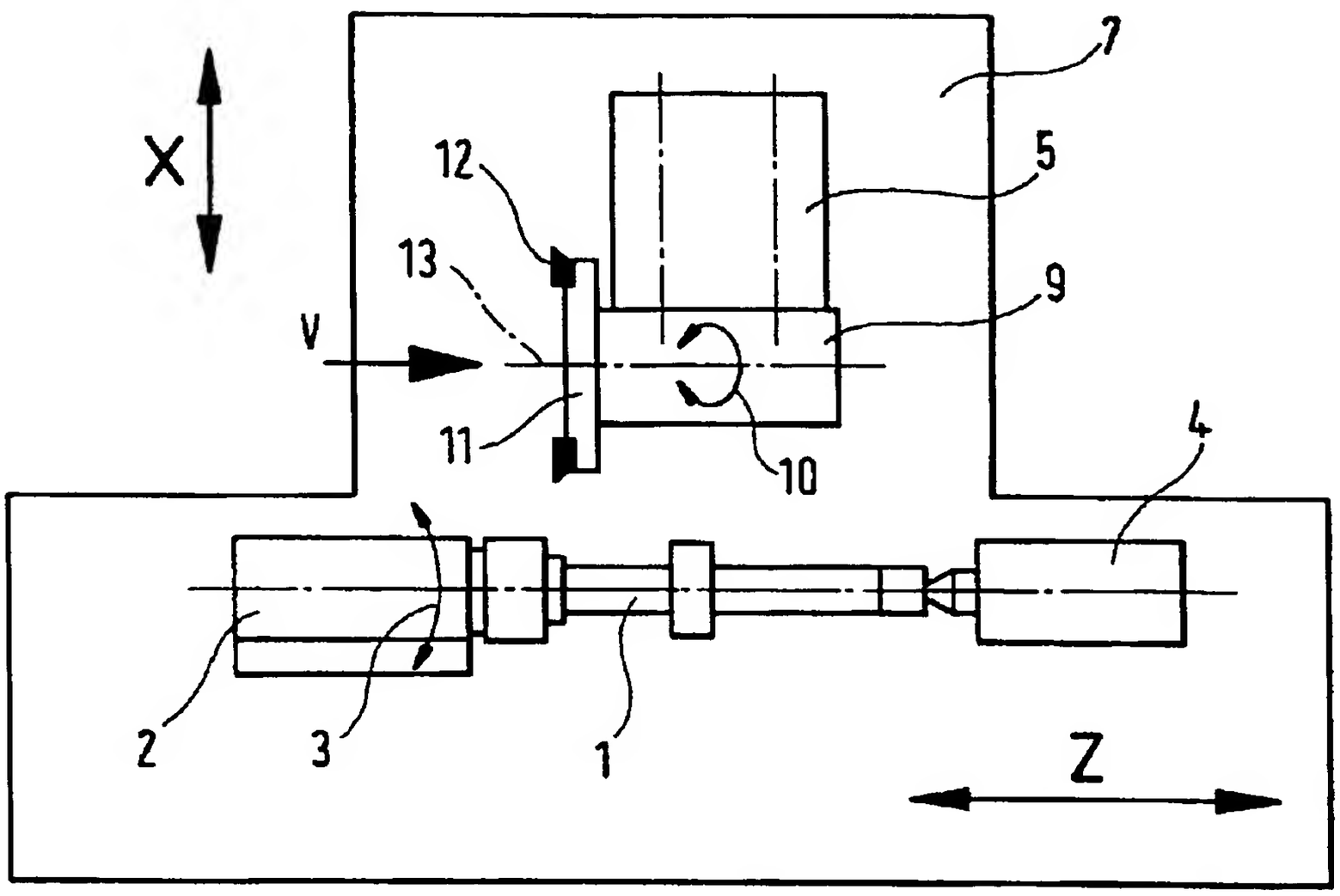

Fig. 3

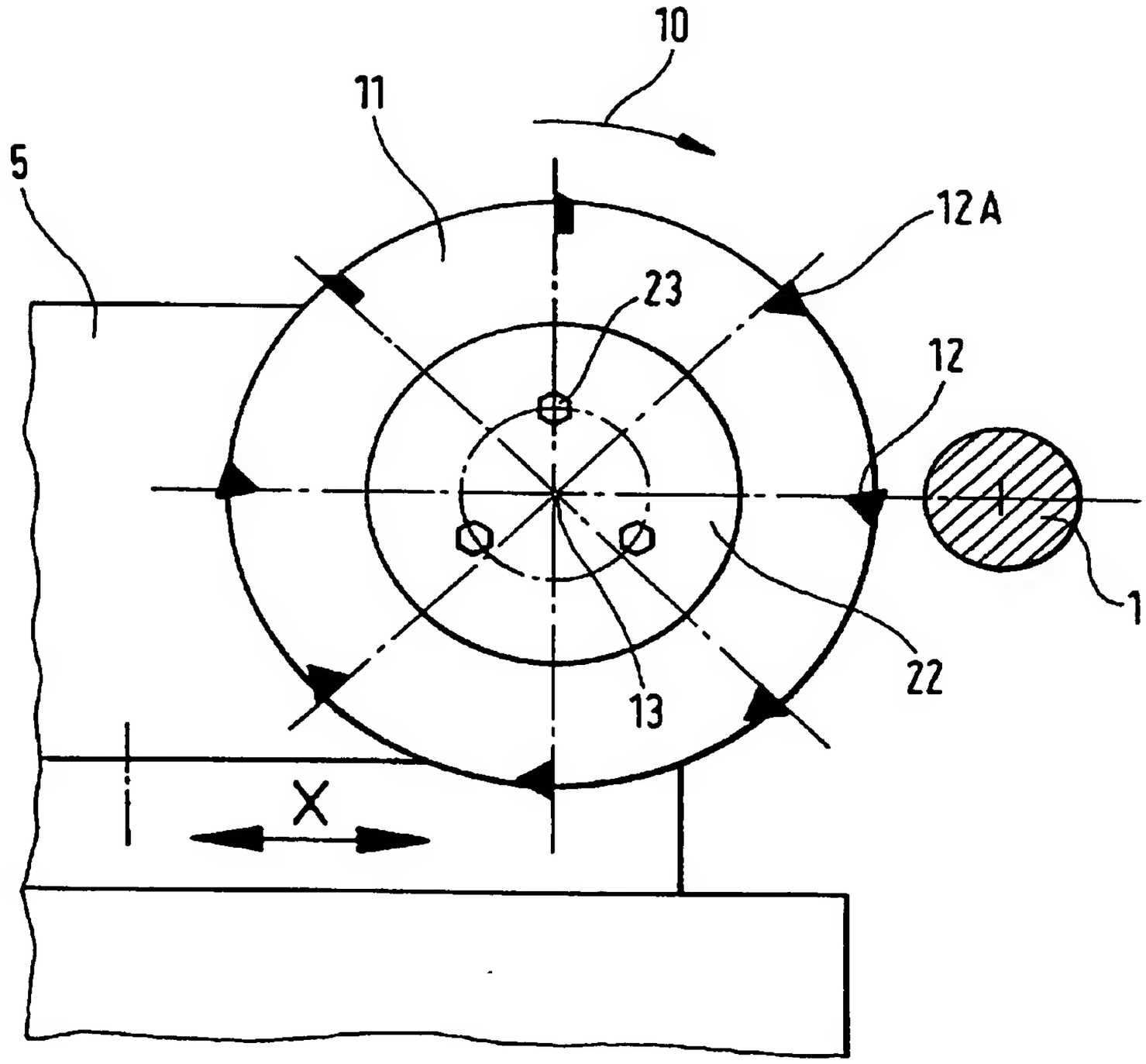

Fig. 4

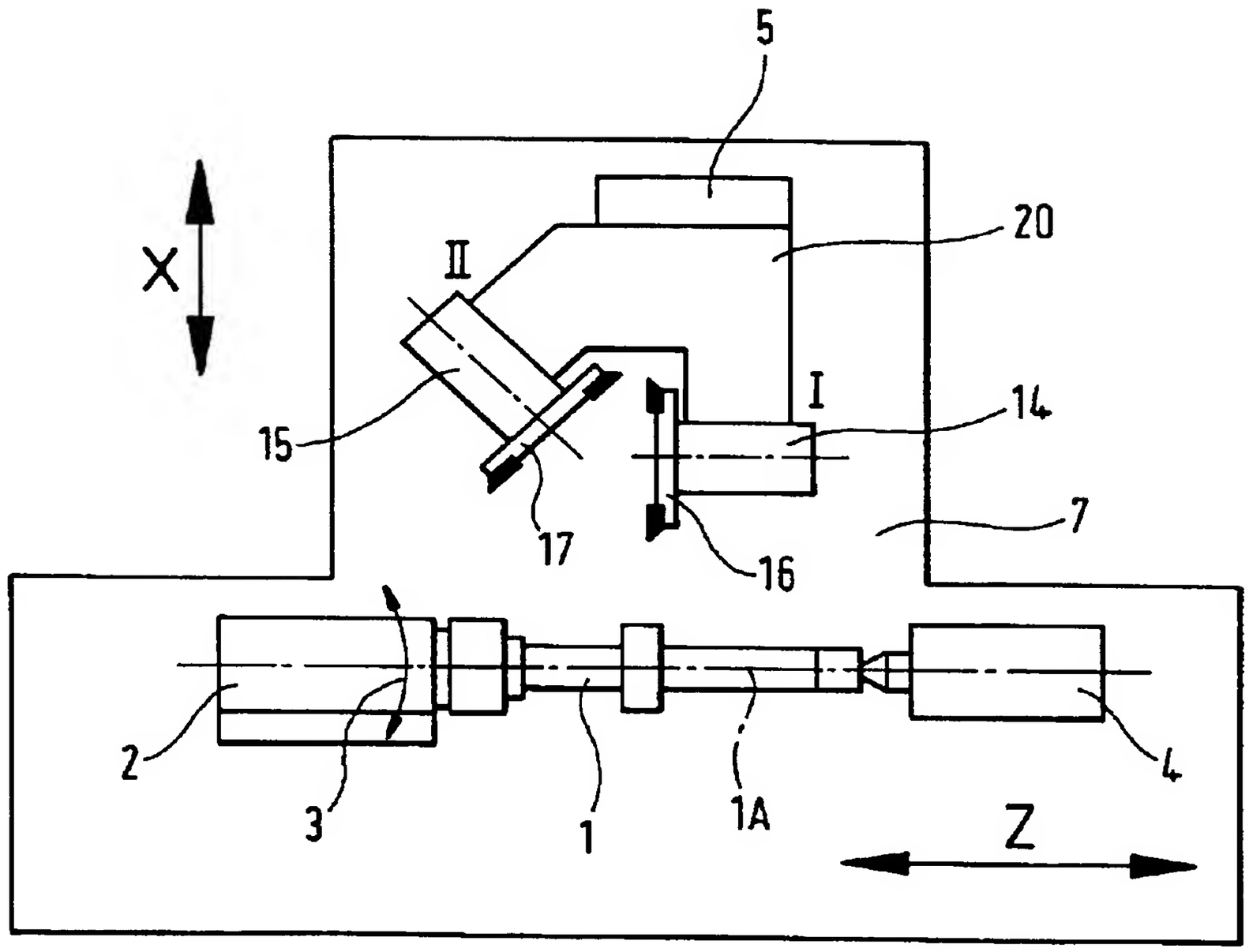

Fig. 5

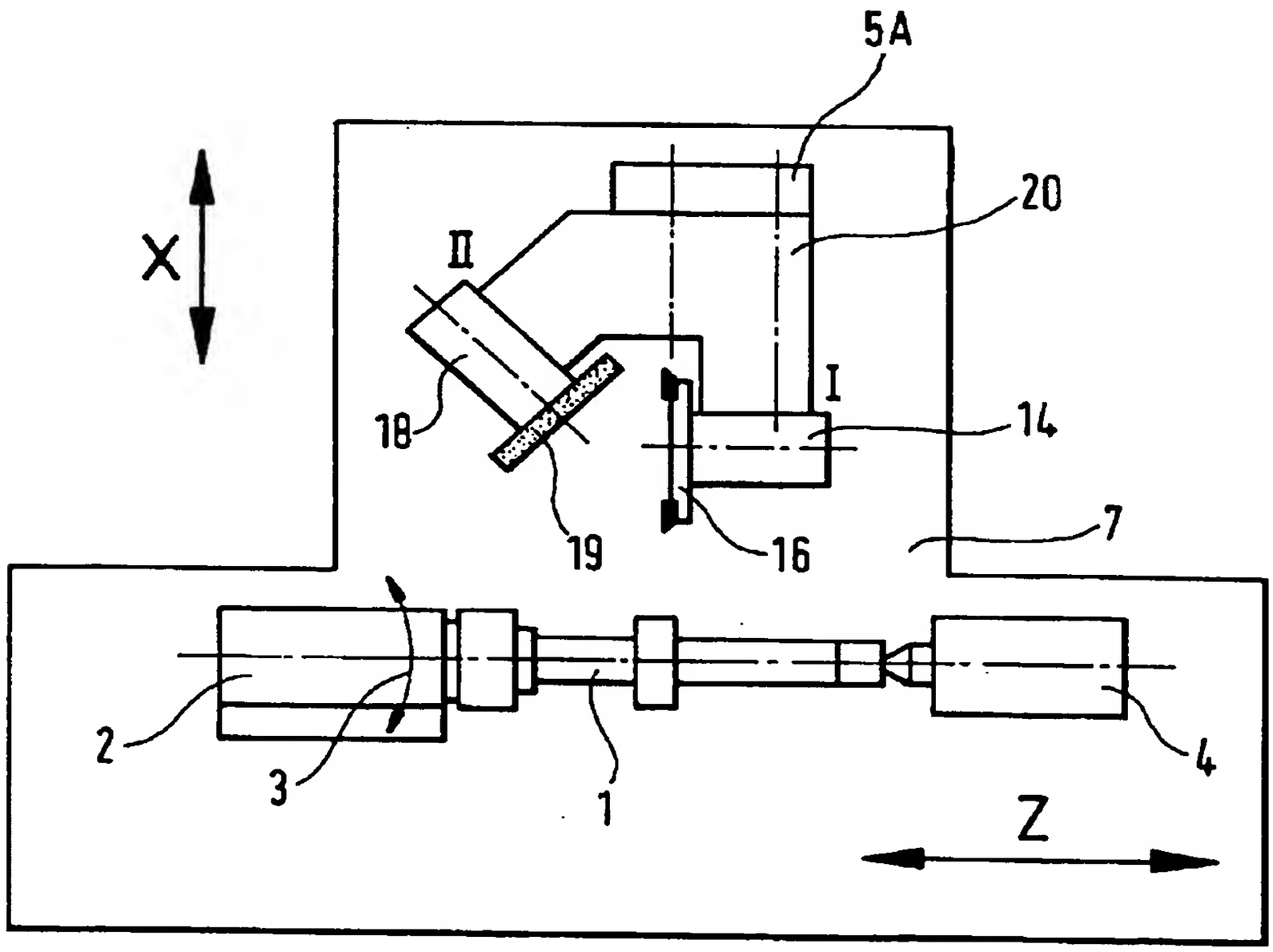

Fig. 6

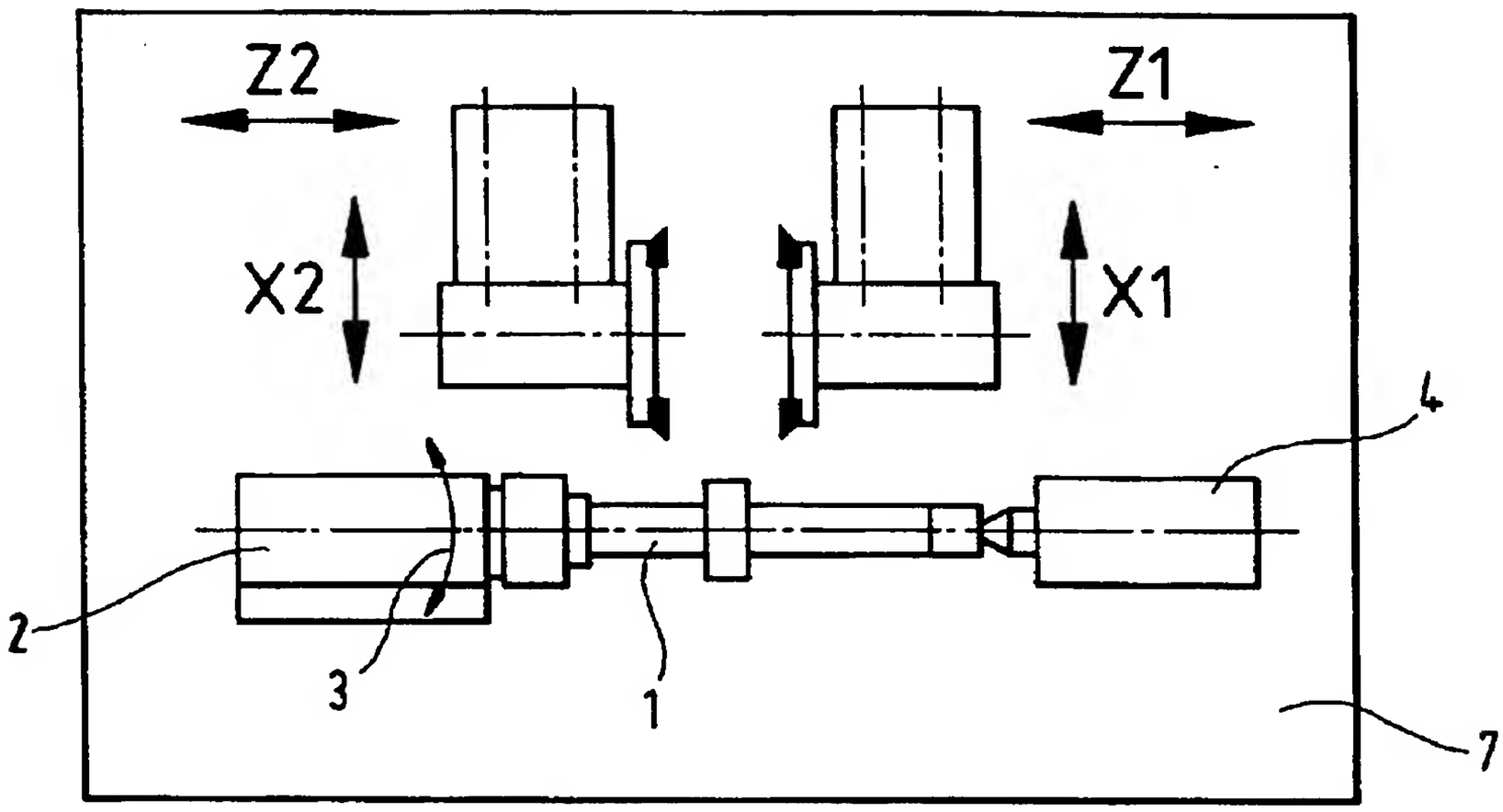

Fig. 7

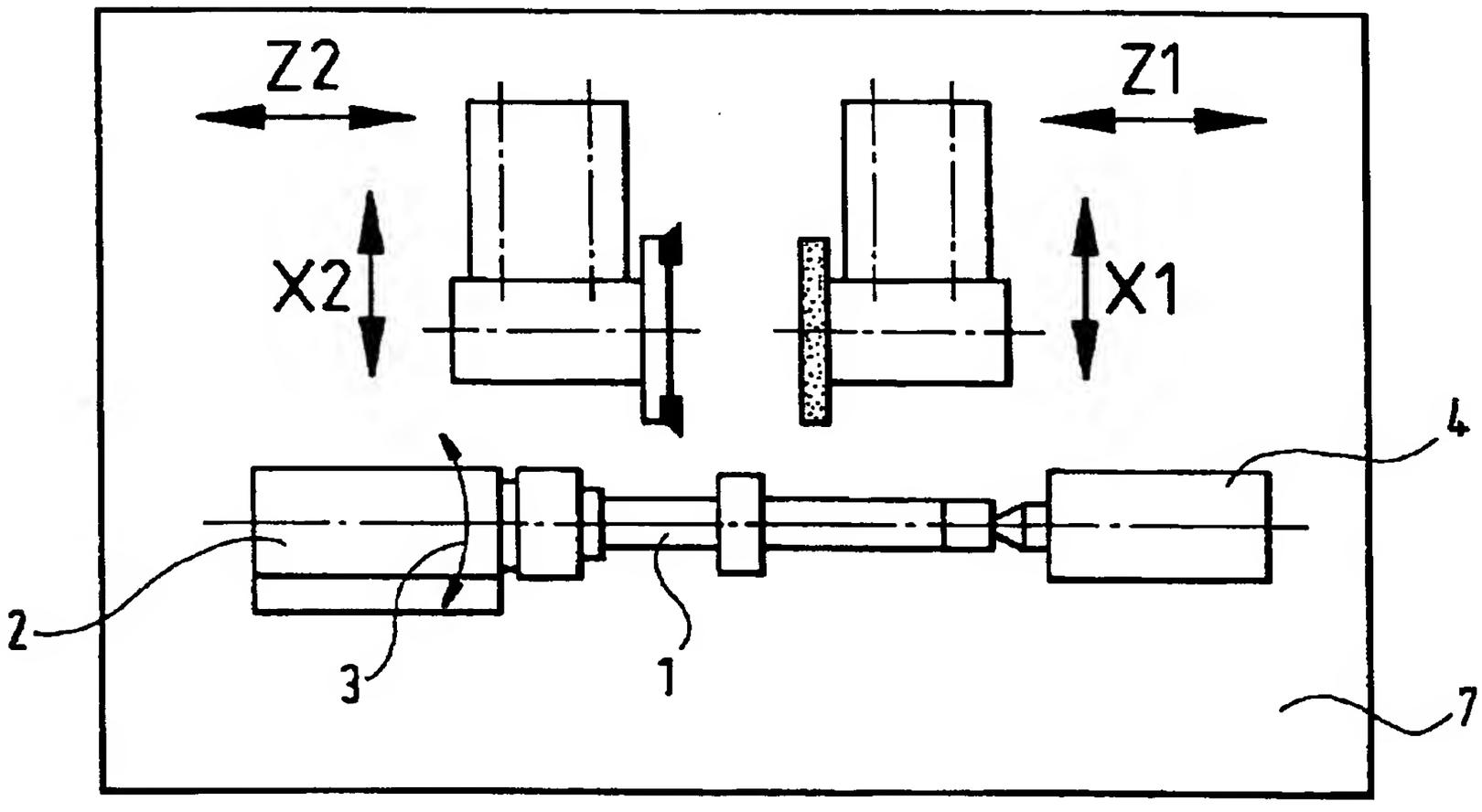

Fig. 8